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CONTAMINATION PATTERNS AT OPERATION JANGLE.(U)
APR 53 R K LAURINO , I G POPPOFF
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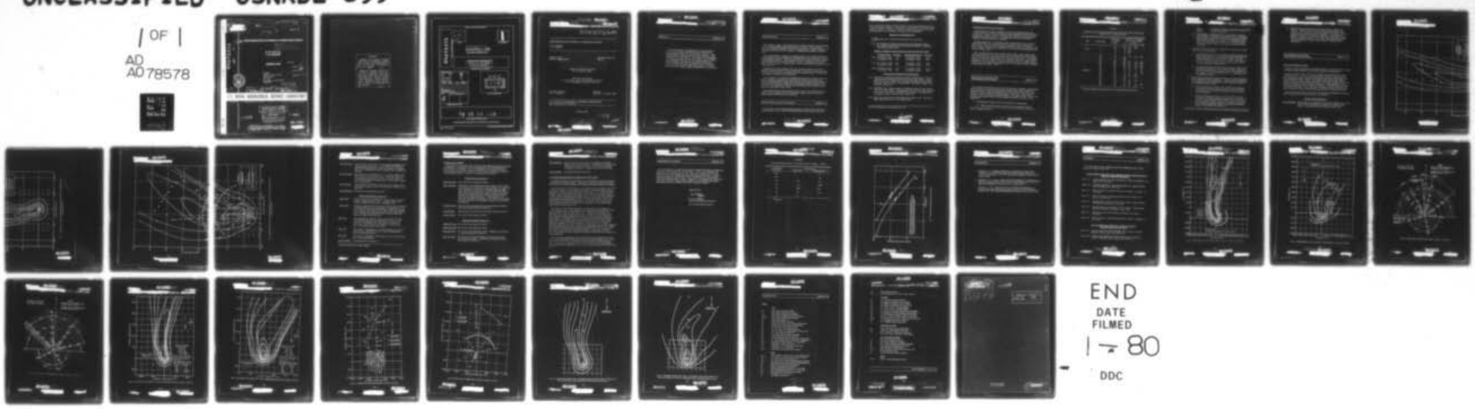

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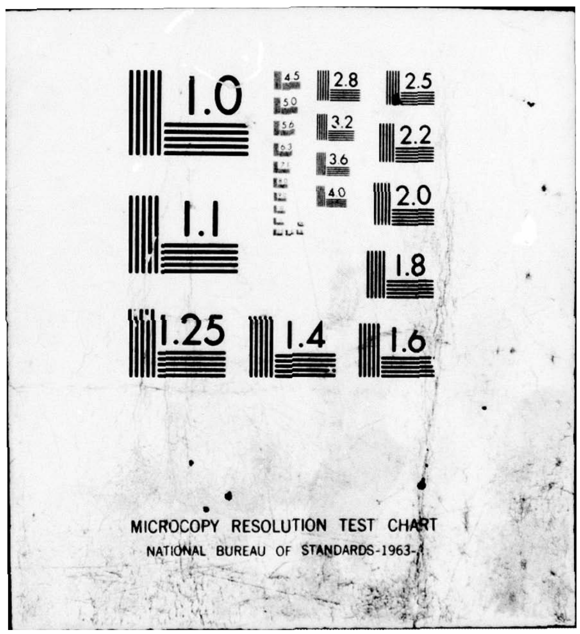
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R. K. Laurino
I. G. Poppoff

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CONTAMINATION PATTERNS AT OPERATION JANGLE

R. K. Laurino
I. G. Poppoff

USNRDL-399
Military Applications

Technical Objective
AW-5c

Military Evaluations Group
W. E. Strope, Head

Scientific Department
E. P. Cooper, Associate Scientific Director
P. C. Tompkins, Scientific Director

Scientific Director
P. C. Tompkins

Director
Captain J. L. Bird, USN

U. S. NAVAL RADIOLOGICAL DEFENSE LABORATORY
San Francisco 24, California

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30 April 1953

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ABSTRACT **USNRDL-399**

The distributions of contamination resulting from bursts at Operation JANGLE have previously been represented on maps as iso-intensity contours. This report uses the data and maps of three projects, and combines this information. The result is two modified iso-intensity maps—one for the surface burst at Operation JANGLE, and one for the underground burst. These modified iso-intensity patterns are believed to be more useful than the maps which were previously made because a wider range of intensities is presented.

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INTRODUCTION

The amount, shape, and extent of the residual radiation field resulting from a contaminating atomic detonation is usually represented by a series of intensity contours at one hour after burst. These contours are variously called dose-rate contours, contamination patterns, and the like.

The contamination contours or patterns left by the surface and underground atomic bursts of Operation JANGLE have been studied by several investigating agencies. Three groups[1,2,3] have reported on the contamination patterns in terms of intensity contours (roentgens per hour at one hour after burst). These groups will be referred to as Projects 2.1a, 2.5a, and 2.1d.

Examination of the intensity contours of these projects reveals an apparent disagreement in (1) the magnitude of the given intensities; and (2) the size of the areas enclosed by given intensity lines. It is further seen that the patterns are incomplete.

In an attempt to reconcile the disagreements and to complete the contours, modified contamination patterns have been constructed here. These modified patterns agree well with the individual project patterns. It is also shown that the apparent disagreements between project contours are not significant, but that the individual project patterns agree with and complement each other.

The modified patterns presented in this report are considered more useful to investigators than the individual project patterns because a wider range of intensities is presented.

SOURCE AND ACCURACY OF DATA

The accuracy of the contamination patterns depends on (1) the measuring stations, their number and distribution in the primary fall-out

[redacted]

area; and (2) the measuring instruments, and the percentage error involved in taking readings. Following is a description of the measuring setups by project. Schematic diagrams showing the locations of measuring stations for each project are given in the Appendix.

Method of Locating Stations

2.1a, 2.5a } Stations were surveyed and plotted on a grid map.

2.1d No method of locating stations given in published report, but unofficial sources state that vehicle odometer readings were taken along roads.

Number of Stations and Distribution from Ground Zero (GZ)

	Surface Burst	See Fig.	Underground Burst	See Fig.
2.1a	16 within 1 mile	A.3	16 within 1 mile	A.4
	11 beyond 1 mile	A.3	13 beyond 1 mile	A.4
2.1d	12* within 1 mile	A.7	56 within 1 mile	A.8
	32 beyond 1 mile	A.7	27 beyond 1 mile	A.8
2.5a	63 within 1 mile	A.9	63 within 1 mile	A.10
	12 beyond 1 mile	A.9	12 beyond 1 mile	A.10

Information on Measuring Instruments

2.1a Constant recording scintillation counters (telemeters). Direct measurement of radiation field at one hour after burst. Instrument error was ± 10 per cent. Energy dependence for gamma energies above 100 Kev is insignificant, as shown in Figs. 2.5a and 2.5b, of Ref (1).

2.5a AN/PDR-T1B. Measurement of radiation field over the period 24 to 70 hr after burst. Instrument error ± 25 per cent. Energy dependence for gamma energies above 100 Kev is insignificant, as shown in Figs. 2.5a and 2.5b, of Ref (2).

2.1d Same instrument used as indicated for Project 2.5a. Period of data collection was 4 to 70 hr after burst.

* Does not include Project 2.5a stations shown in Fig. A.7.

Information on Decay Corrections

The telemeter records of Project 2.1a were considered the most reliable because no decay corrections were required to give dose rates at one hour. However, there were too few telemeter records to give complete dose rate contours. Consequently, the monitor data of Projects 2.5a and 2.1d were required.

By the use of the $t^{-1.2}$ equation, monitor data taken from 4 to 70 hr after burst were corrected back to the reference time of one hour after burst. The use of this equation introduces an error, which is not great enough to destroy the usefulness of the data and probably does not exceed ± 30 per cent.

This estimate of error was derived from Table 1 which shows how dose rates measured at various times and corrected for decay compare with the actual dose rate measured at one hour after burst. The latter values are based on the Project 2.1a telemeter records.* Only records showing 10 r/hr or greater at one hour after burst are included, since lower dose rates had no appreciable effect on the shape of the completed contours given in Figs. 1 and 2.

METHOD OF CONSTRUCTING THE MODIFIED PATTERNS

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Even with the measurements of all three groups available, considerable interpretation is necessary before the contour maps can be drawn. It appears that part of the disagreement in the contour maps of the three projects is due to different interpretations of the data. The authors' method of constructing the modified maps is presented below. (For comparison, the contour maps of the individual projects are given in the Appendix.)

1. Selecting the contour lines to be drawn by considering:

   a. Which intensity lines could be drawn completely closed.

---

* Figs. 6.1 through 6.12, WT-370.

[redacted]

TABLE 1

Variation of Corrected Readings from Actual One Hour Dose Rate, Project 2.1a Telemeter Data

Shot	Station Number	Actual Reading at One Hour (r/hr)	Corrected ($t^{-1.2}$) Readings from 4 to 70 hr after Burst[a] (r/hr)			
			4	24	48	70
	1	500	450	500	(620)	-
	7	75	75	(90)	-	-
Surface	3	30	25	(35)	-	-
	2	40	30	(35)	-	-
	101	100	90	90	100	(100)
	107	15	(20)	-	-	-
	113	12	(11)	-	-	-
	102	500	480	550	600	(600)
	108	450	430	400	450	500
	114	400	430	420	500	(420)
	120	250	200	240	300	320
	123	100	90	90	95	100
Underground	127	25	20	25	27	(25)
	129	12	9	12	13	(12)
	103	100	100	120	(130)	-
	109	40	35	45	(48)	-
	115	10	(9)	-	-	-
	121	60	52	70	(80)	-
	124	20	16	(19)	-	-
	128	20	20	24	25	(25)
	104	100	100	90	(100)	-

(a) Values in parentheses are taken from part of curves extrapolated beyond plotted data.

[redacted]

The n[illegible] and location of measuring stations determined whether [illegible] could be completed.

b. Which range of intensities it was necessary to portray. This range was considered to include lines of immediate military interest and lines needed for scaling resultant data to other yields. Of course, all completely closed lines that could be drawn might be useful, but proper spacing of contour lines in the range of intensities was important.

2. Drawing the contour lines or segments of contours for which data were most complete:

a. Drawing smooth curves through points which showed the appropriate intensity or which were within the limits of error estimated for the individual values. For the JANGLE bursts, the limits of error were estimated as ± 25 per cent for monitor measurements and ± 10 per cent for telemeter measurements.

b. Interpolating between station measurements when it was necessary to draw part of an intensity line. Interpolation was required in areas where no measurements had been taken. For the JANGLE bursts, interpolation was by graphical means.*

3. Finishing the drawing of chosen contours for which data were less complete or less compatible. Contours were completed by interpolation and extrapolation using completed contours or segments as base points.

a. Near ground zero, intensity was plotted on a graph as a function of distance along azimuths from the crater. Then distances for required intensities were selected from the graph.

b. Maximum downwind extent of a given contour was determined by plotting change in intensity as a function of distance along the major axis of the system of contours already drawn. (Here, major axis refers to a smooth curve drawn through the points of maximum downwind extent of all completed contours.)

---

* If less accuracy is required, interpolation can be simply accomplished by visual estimate on the map.

[redacted]

4. Making final adjustments by checking contours against one another. Within the restrictions imposed by the data, the contours were adjusted so that they appeared to have resulted from the same meteorological conditions. The shapes of different contours were made as similar as possible by drawing the contours parallel to each other where data permitted. The most reliable contours were used as a basis for this adjustment.

DISCUSSION OF MODIFIED CONTAMINATION PATTERNS

USNRDL-399

General Agreement of Data

Figures 1 and 2 represent the modified patterns constructed here using the station measurements for the three projects just discussed.

Because in most cases each project made its measurements in different locations, it was not usually possible to check values directly. But contour lines were drawn in substantial agreement with almost all of the intensity values. Thus, most values—far from being contradictory—actually complement each other. The same can be said for the contour maps drawn by the different projects. (See Appendix.) The high-level radiation contours drawn by Project 2.5a fall within the inner line drawn by Project 2.1d. With two exceptions (discussed later), the same agreement can be noted between the Project 2.5a and 2.1d maps.

The general agreement can best be illustrated by studying the measurements along given iso-intensity lines, as follows:

Surface Burst (Figure 1)

500 r/hr line: Note Project 2.1a Station 1 (located as shown in Fig. A.3) and Project 2.5a Station G3 which were about 50 yd apart. Intensity levels are within ± 10 per cent.

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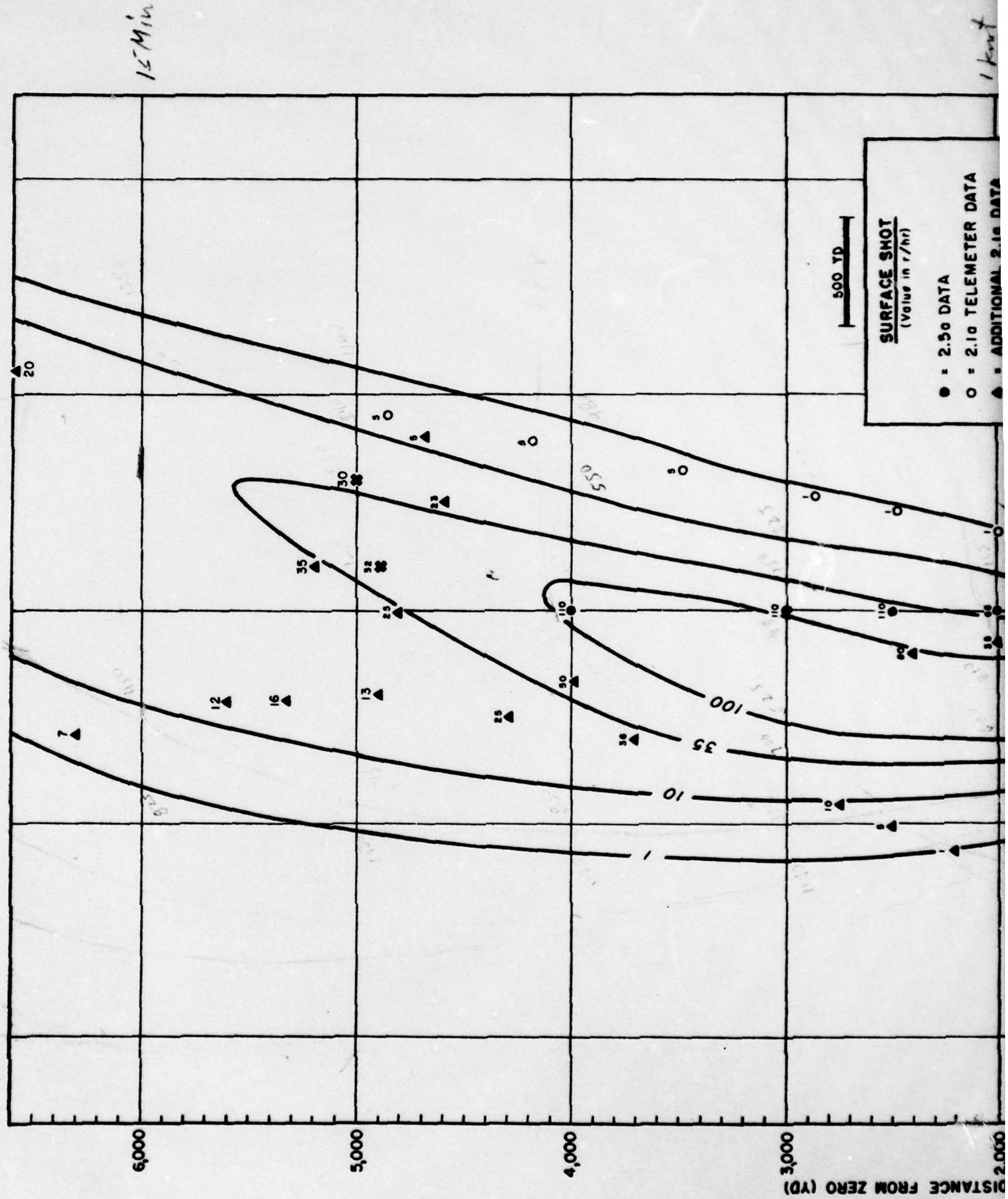
15 Min
1 knot
SURFACE SHOT
(Value in r/hr)
500 YD
● = 2.5a DATA
○ = 2.1a TELEMETER DATA
▲ = ADDITIONAL 2.1a DATA
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5,000
4,000
3,000
2,000
DISTANCE FROM ZERO (YD)

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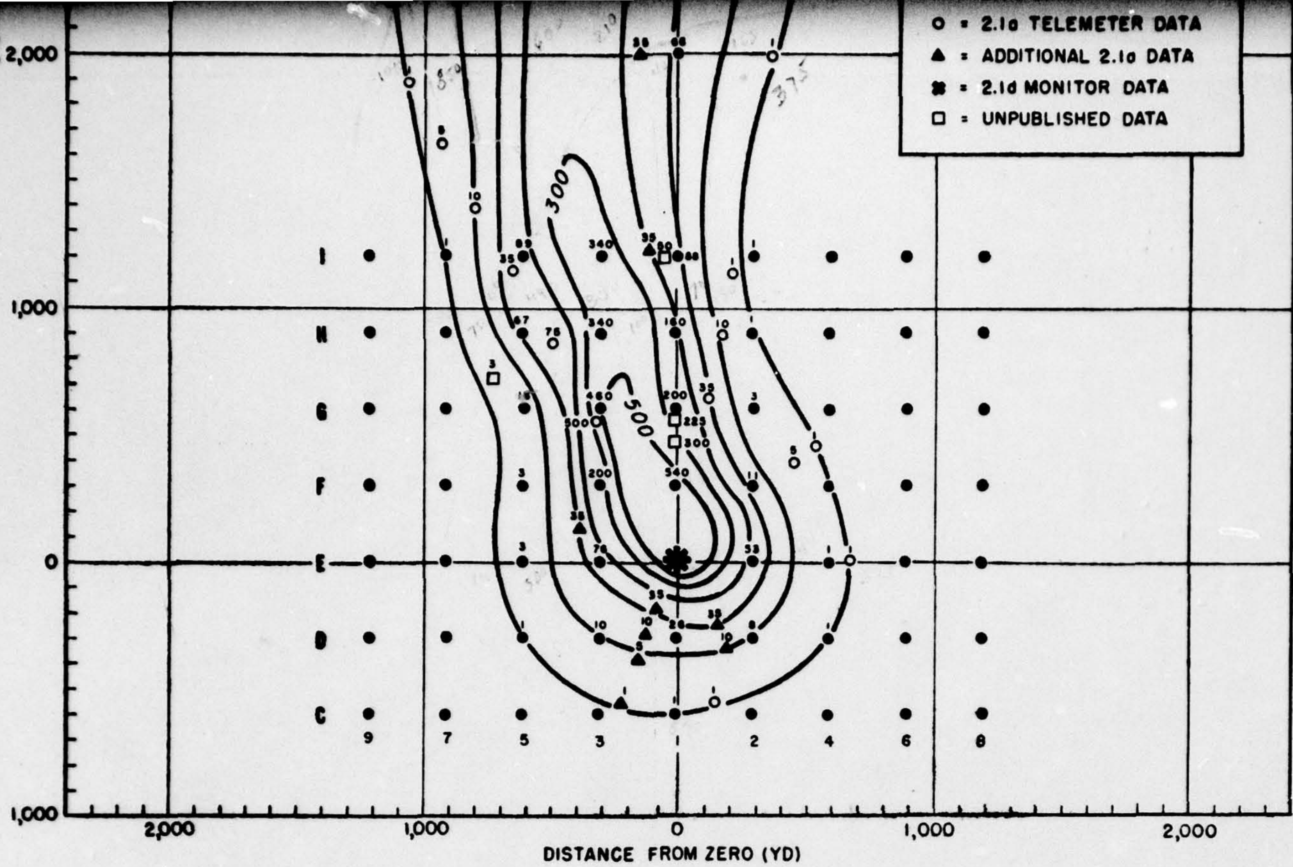

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2.5 miles

Fig. 1 Modified Contamination Pattern for Surface Burst with Intensities in Roentgens per Hour at One Hour after Burst

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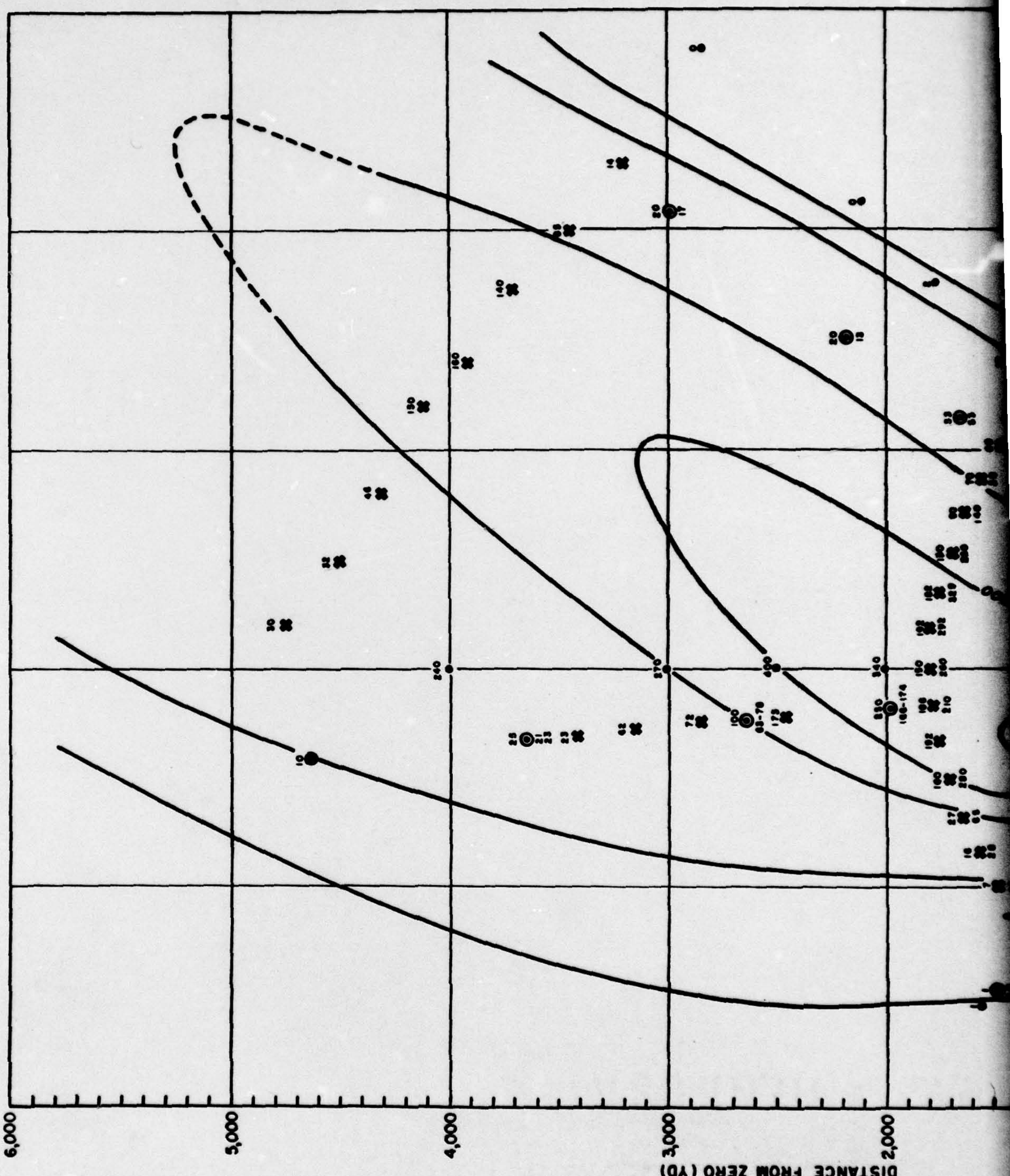

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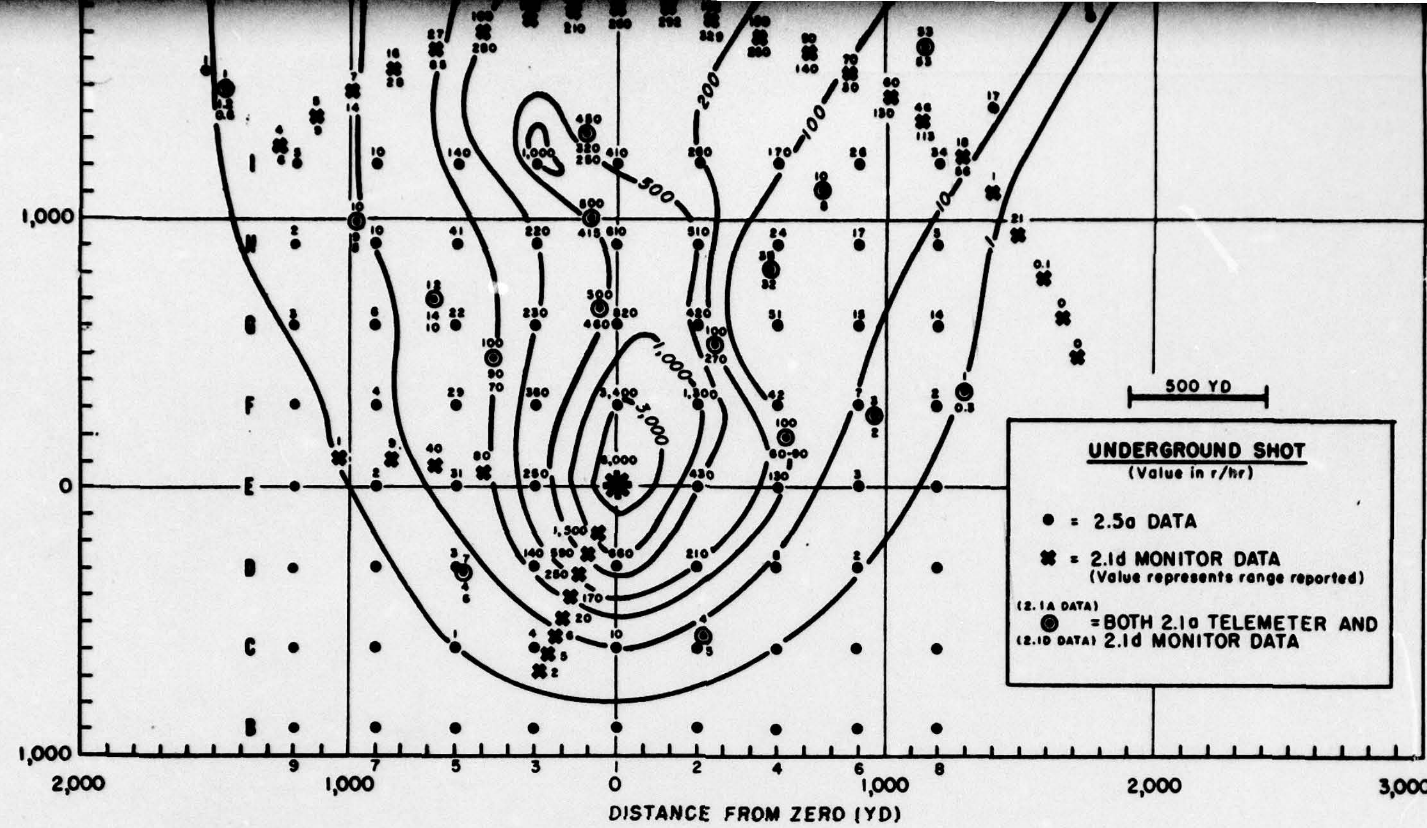

Fig. 2 Modified Contamination Pattern for Underground Burst with Intensities in Roentgens per Hour at One Hour after Burst

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300 r/hr line: Note Project 2.5a Station G1 and unpublished-data* stations between G1 and F1. The Project 2.5a value of 200 increased uniformly toward the crater to 225 and 300 r/hr at unpublished-data* stations (over a range of 150 yd).

100 r/hr line: Note Project 2.1a Stations 1, 7, 13, and 2, (Fig. A.3), and Project 2.5a monitor values. This line drawn in accordance with Project 2.5a data fits well inside the indicated stations for Project 2.1a, where lower values were encountered.

35 r/hr line: Line drawn in accordance with Project 2.1a map. No serious discrepancy exists with data from Projects 2.1d and 2.5a.

Lower levels: No serious disagreement in data.

Underground Burst (Figure 2)

3,000 r/hr: Project 2.5a value at Station F1 is only value recorded in this range outside of crater. Crater values estimated at 6,000 to 8,000 r/hr. (Project 2.1d.)

1,000 r/hr: Projects 2.5a and 2.1d both report values above 1,000 r/hr at 300 and 200 yd from ground zero, respectively. No lower values within the region of the 1,000 r/hr contour are reported. One Project 2.5a value reported 1,000 r/hr at I3. This point substantiated by values on fall-out material taken from this area.

500 r/hr: Good agreement between values for Project 2.5a and 2.1a stations (Project 2.5a Stations G1, H1, I1, and Project 2.1a Stations 102, 108, and 114, shown in Fig. A.4). The Project 2.1d values are low at Project 2.1a stations (discussed later).

200 r/hr: This line is compatible with all data within one mile of ground zero. Beyond one mile, some disagreement arises (discussed later).

100 r/hr: This line is compatible with Project 2.1a and 2.1d values 2 to 3 miles downwind.

Lower levels: Compatible with all values.

---

* Measurements taken by W. E. Strope, USNRDL.

Disagreement of Data

There were a few points where values of the different projects seemed incompatible. In general, this incompatibility was not significant in terms of over-all shape, size, and magnitude of iso-intensity lines. The following discussion includes the cases where differences between measurements made a selection or adjustment necessary.

Surface Burst (Figure 1)

500 r/hr line; No serious discrepancies noted.

300 r/hr line; Difference in the downwind extent of this line as shown in the Project 2.1d and 2.5a reports (Figs. A.5 and A.9). This difference seems due to interpretation of inadequate data by both projects. It will be noted on Fig. 1 that a line bisecting the downwind contours would pass through the region between 1,200 and 4,000 yd where there are no reported values. Consequently, the 300 r/hr downwind extent (Fig. 1) is drawn at a median distance and must be considered to have an uncertainty of ± 400 yd.

100 r/hr line; Lack of values downwind gives the downwind extent of this line an uncertainty of ± 400 yd.

35 r/hr line; Uncertainty of ± 800 yd for the same reason as above.

Lower levels; No serious discrepancies noted.

Underground Burst (Figure 2)

3,000 r/hr line: No serious discrepancies noted.

1,000 r/hr line: No serious discrepancies noted.

500 r/hr line; No serious discrepancies noted. Probable uncertainty of downwind extent is ± 200 yd.

200 r/hr line; Discrepancies between values of all three projects. See discussion below. Probable uncertainty in downwind extent is ± 400 yd.

[redacted]

100 r/hr line: Beyond 1,200 yd downwind, discrepancies between Project 2.5a values and those of Projects 2.1a and 2.1d, which agree with each other. See discussion below. Probably uncertainty of downwind extent is ± 600 yd.

Lower levels: No significant discrepancies.

Resolving Disagreements in Underground Burst Data

As indicated earlier, the Project 2.1a scintillation counter data were considered the most reliable. Therefore, when discrepancies arose, the Project 2.1d and 2.5a data were compared with Project 2.1a values.

The main error in the Project 2.5a underground burst data was in the values for stations on the north line between 2,000 and 4,000 yd from ground zero (Stations N1, N3, N4, and N5, Fig. A.9). Measurements along this line were made 70 hr after burst and after a severe windstorm. Measurements in the same general area made before and after this windstorm indicated the likelihood that considerable amounts of contaminant had been moved to this area from the crater area. This difficulty was realized by the Project 2.5a group, and consequently these measurements were ignored in drawing the iso-intensity map appearing in the final report.

The Project 2.1d values disagree with the Project 2.1a values in (1) the general area of the one mile arc downwind of ground zero, and (2) at monitor points of the Project 2.1a stations up the north line (Stations 108, 114, and 120, Fig. A.4). Actually, the Project 2.1d measurements made along the one mile arc are not self-consistent. Discrepancies ranging from 50 to 100 per cent are noted in measurements which were made at the same stations at different times and which were corrected to the reference time of one hour after burst. These discrepancies are not explained in the Project 2.1d report. Although some may be due to error in correcting for decay (see Table 1), the discrepancies cannot be completely explained by this error. When the Project 2.1d and 2.1a data are compared at the time the monitor data were collected (thus eliminating decay corrections), the Project 2.1d measurements average 30 to 50 per cent below the Project 2.1a measurements.

To resolve the disagreements between the values along the one mile arc, it was assumed that the low values at stations along the arc were 30 to 50 per cent low. The addition of about 50 per cent to the low values on the arc brought them close to the high values determined at the same stations, and makes the values compatible with the Project 2.1a data.

[redacted]

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It is of interest to compare total areas enclosed by given iso-intensity contours of the two bursts. From Figs. 1 and 2, for example, the total area enclosed by the 500 r/hr contour is 160,000 sq yd for the surface burst, and 700,000 sq yd for the underground burst. Table 2 has been prepared, giving total areas enclosed by the iso-intensity contours shown on Figs. 1 and 2. Figure 3 is a graph based on Table 2. The curves of Fig. 3 allow determination of areas within any given intensities which lie between the values shown in Table 2.

Approved by:

E. P. Cooper

E. P. COOPER
Associate Scientific Director

For the Scientific Director

[redacted]

TABLE 2

Areas Enclosed within Iso-intensity Lines of Figs. 1 and 2

Iso-intensity Line (r/hr at 1 hr)	Area (10^3 sq yd)	
	Surface Burst	Underground Burst
3,000	-	85
1,000	-	260
500	160	700
300	470	1,500[a]
200	650[a]	2,700
100	1,700	7,000
35	3,700	-

[a] Estimated.

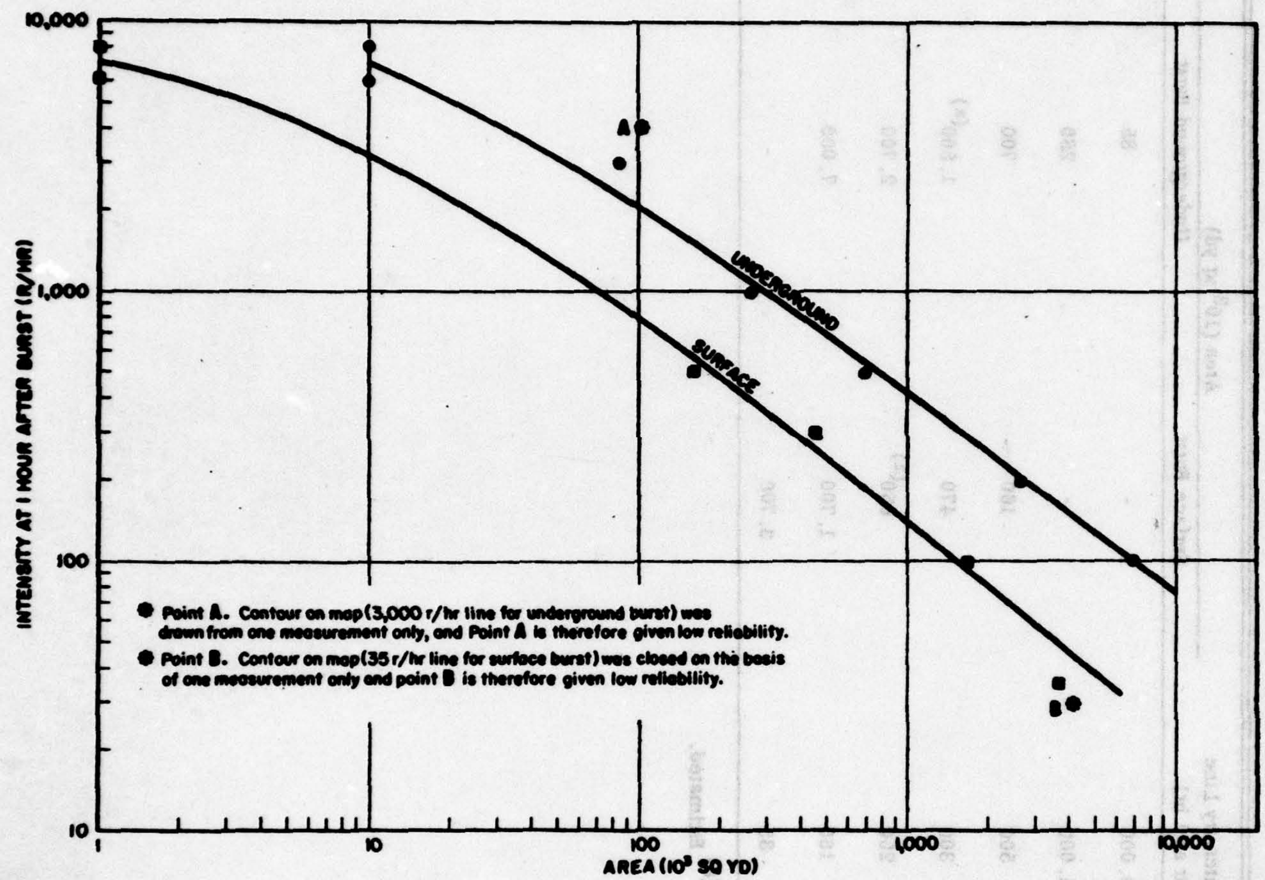

Fig. 3 Areas Enclosed within Given Iso-intensity Lines

1. Costrell, L., "Gamma Radiation as a Function of Time and Distance," Armed Forces Special Weapons Project Secret Restricted Data Report, WT-370, Operation JANGLE, Project 2.1a, 1 April 1952.

2. Poppoff, I. G., et al., "Fall-out Particle Studies," Armed Forces Special Weapons Project Secret Restricted Data Report, WT-371, Operation JANGLE, Project 2.5a-2, 2 April 1952.

3. Johnson, A. W., "Monitor Survey of Ground Contamination," Armed Forces Special Weapons Project Secret Restricted Data Report, WT-370, Operation JANGLE, Project 2.1d, 22 May 1952.

Ten illustrations from AFSWP Operation JANGLE reports, Projects 2.1a, 2.5a-2, and 2.1d.

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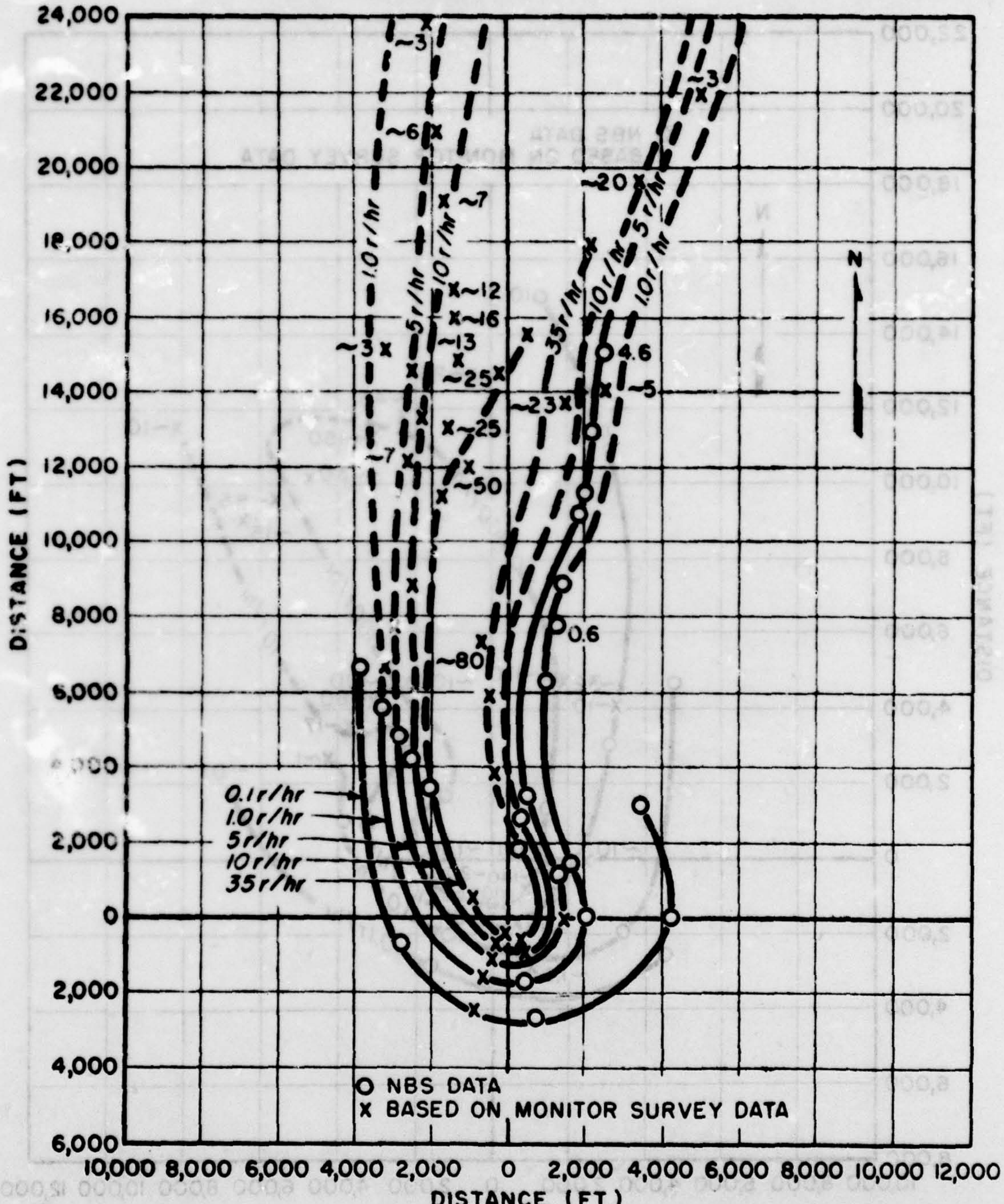

Fig. A.1 Surface Burst, Iso-rate Contours at 1 Hour for Project 2.1a (Fig. 6.17, WT-370)

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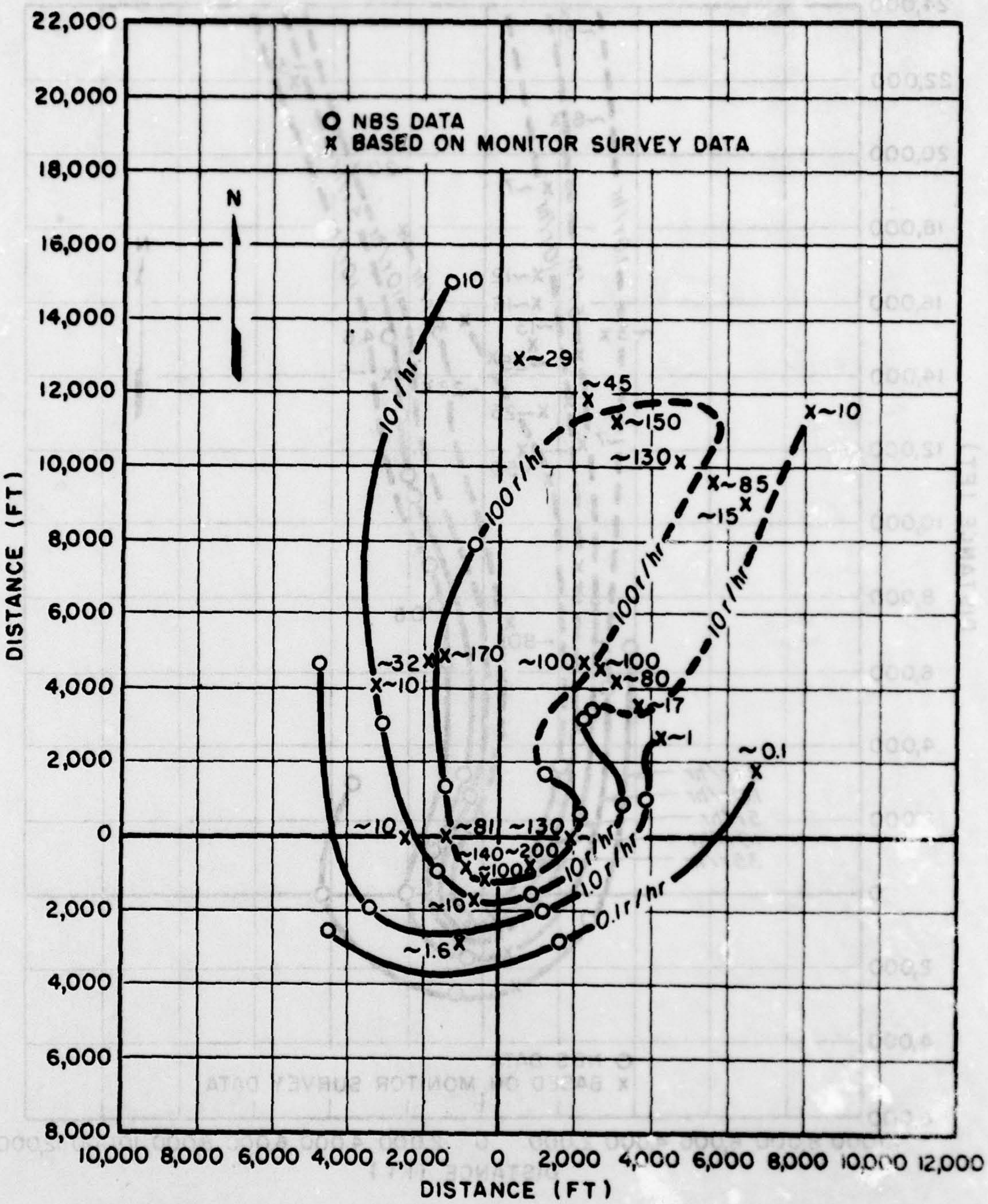

Fig. A.2 Underground Burst, Iso-rate Contours at 1 Hour for Project 2.1a (Fig. 6.21, WT-370)

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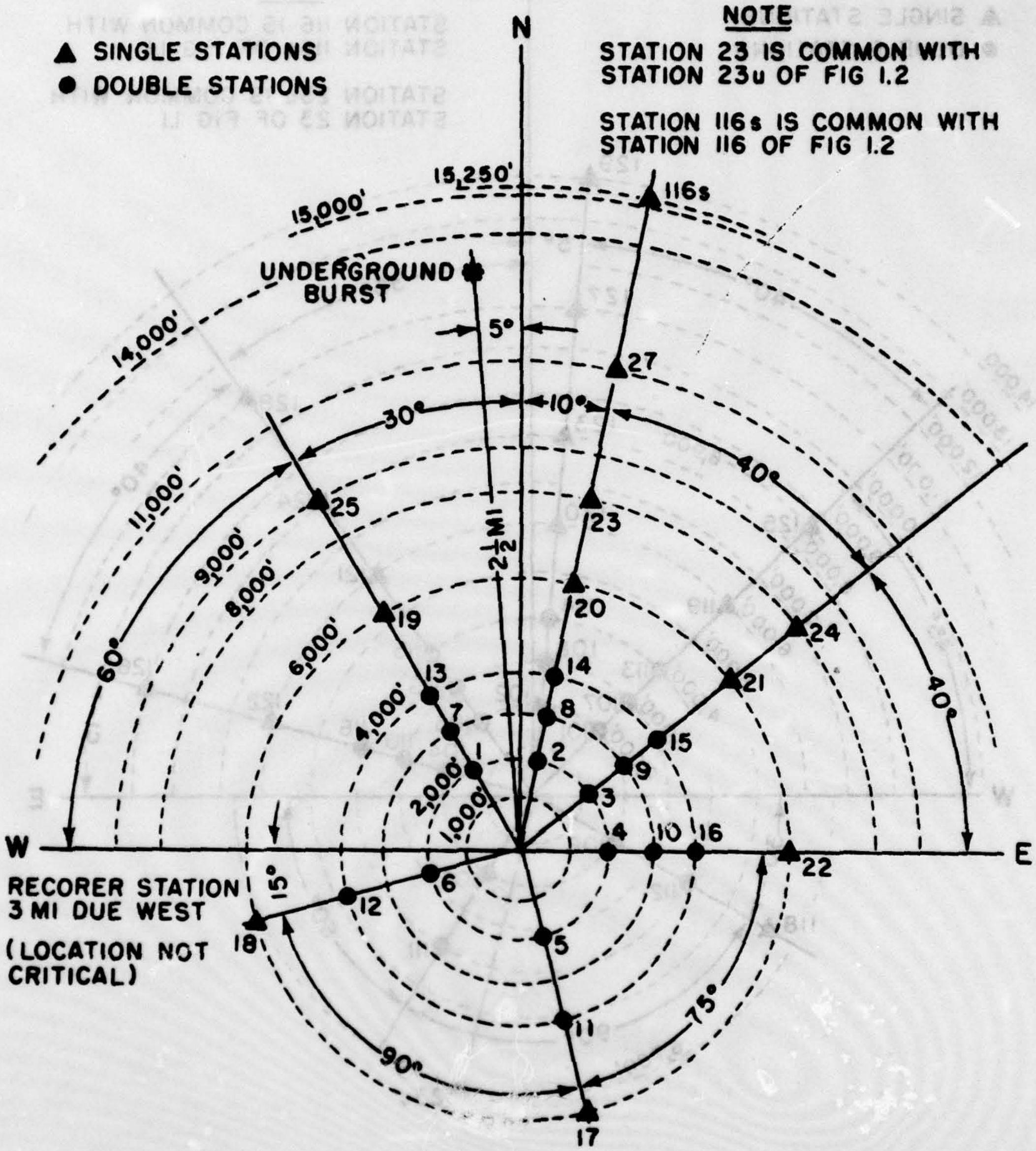

Fig. A.3 Station Pattern of Surface Burst for Project 2.1a (Fig. 1.1, WT-370)

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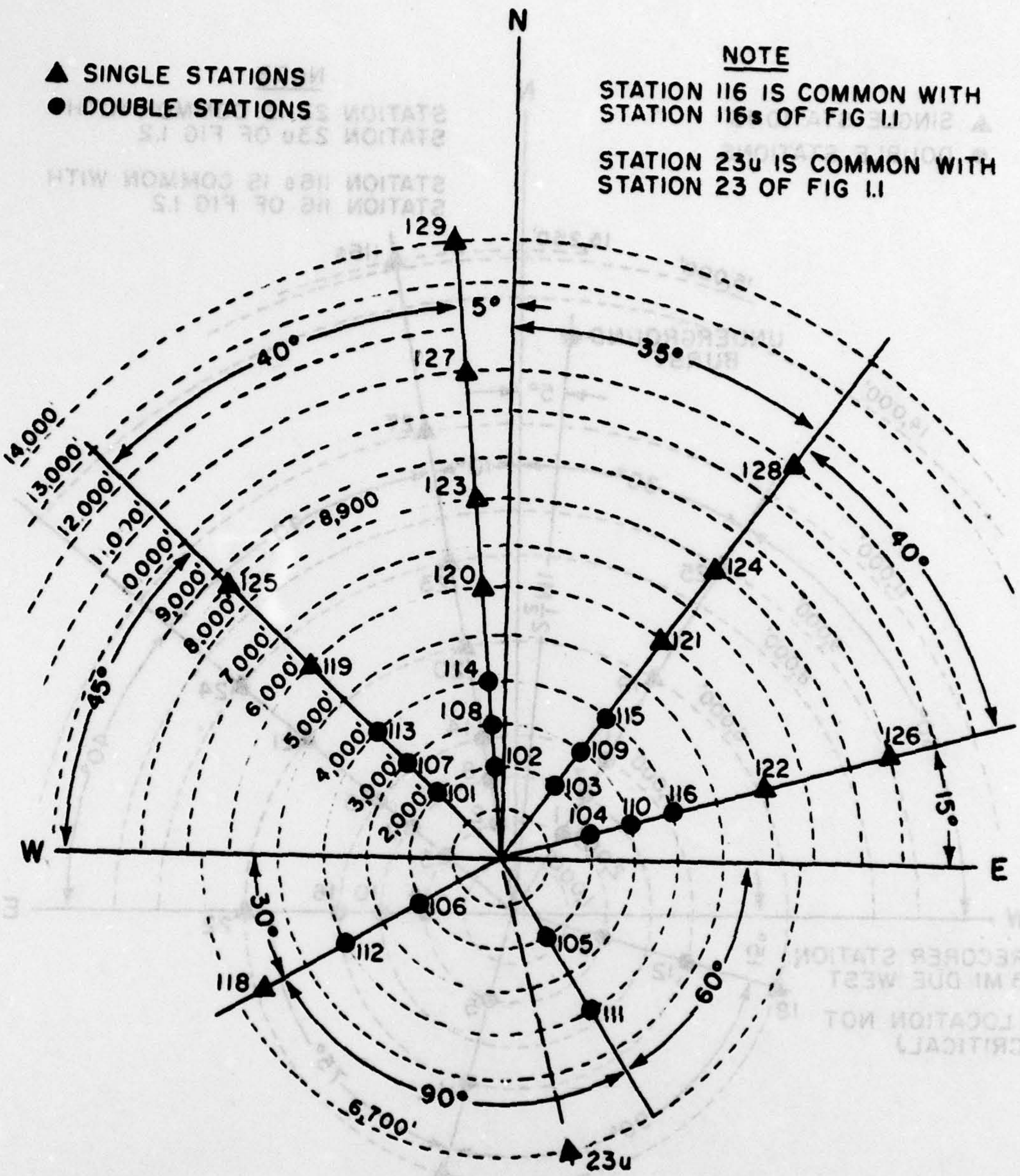

Fig. A.4 Station Pattern of Underground Burst for Project 2.1a (Fig. 1.2, WT-370)

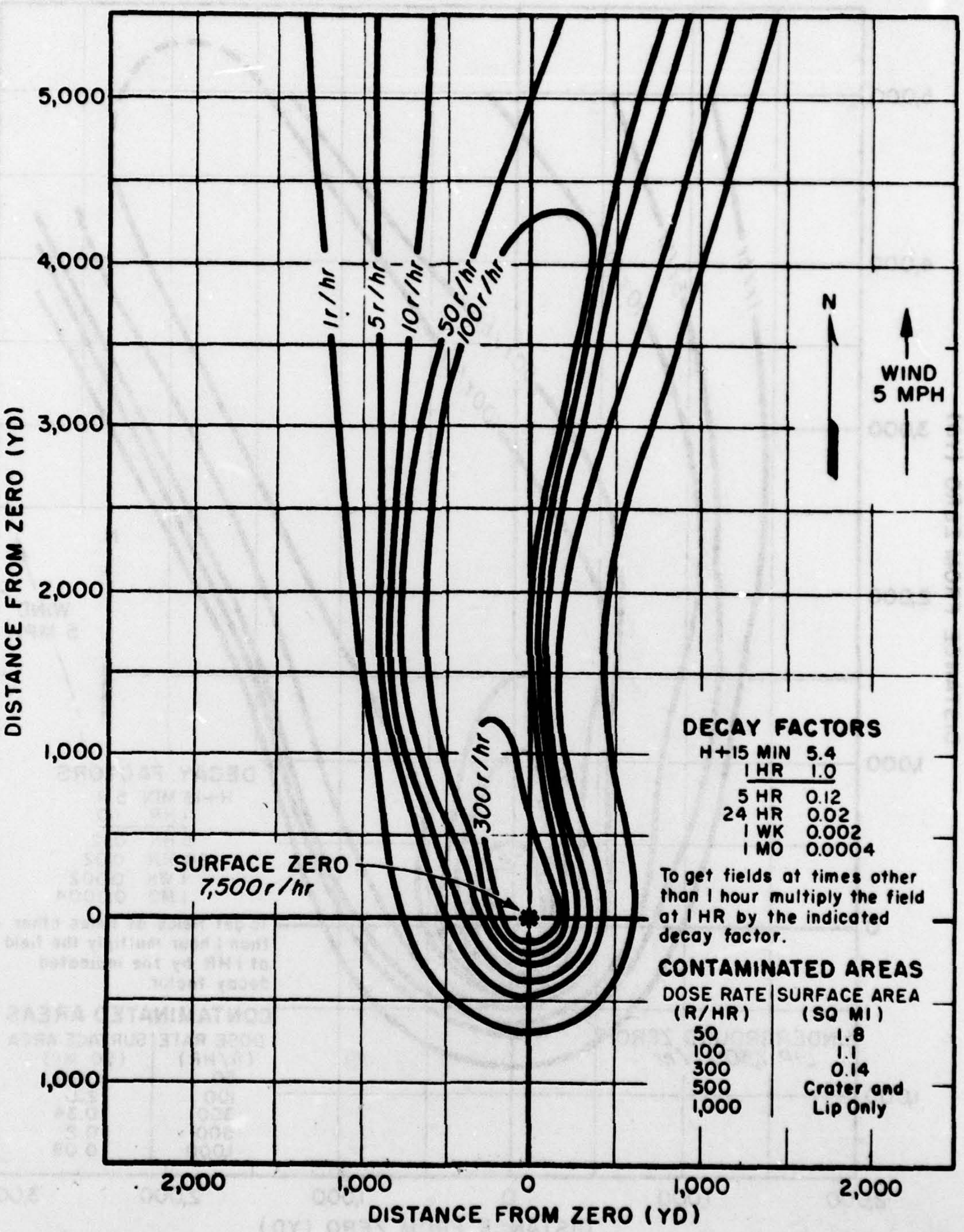

Fig. A.5 Gamma Dose-rate Contours at H + 1 hour, Surface Burst for Project 2.1d (Fig. 1, WT-370)

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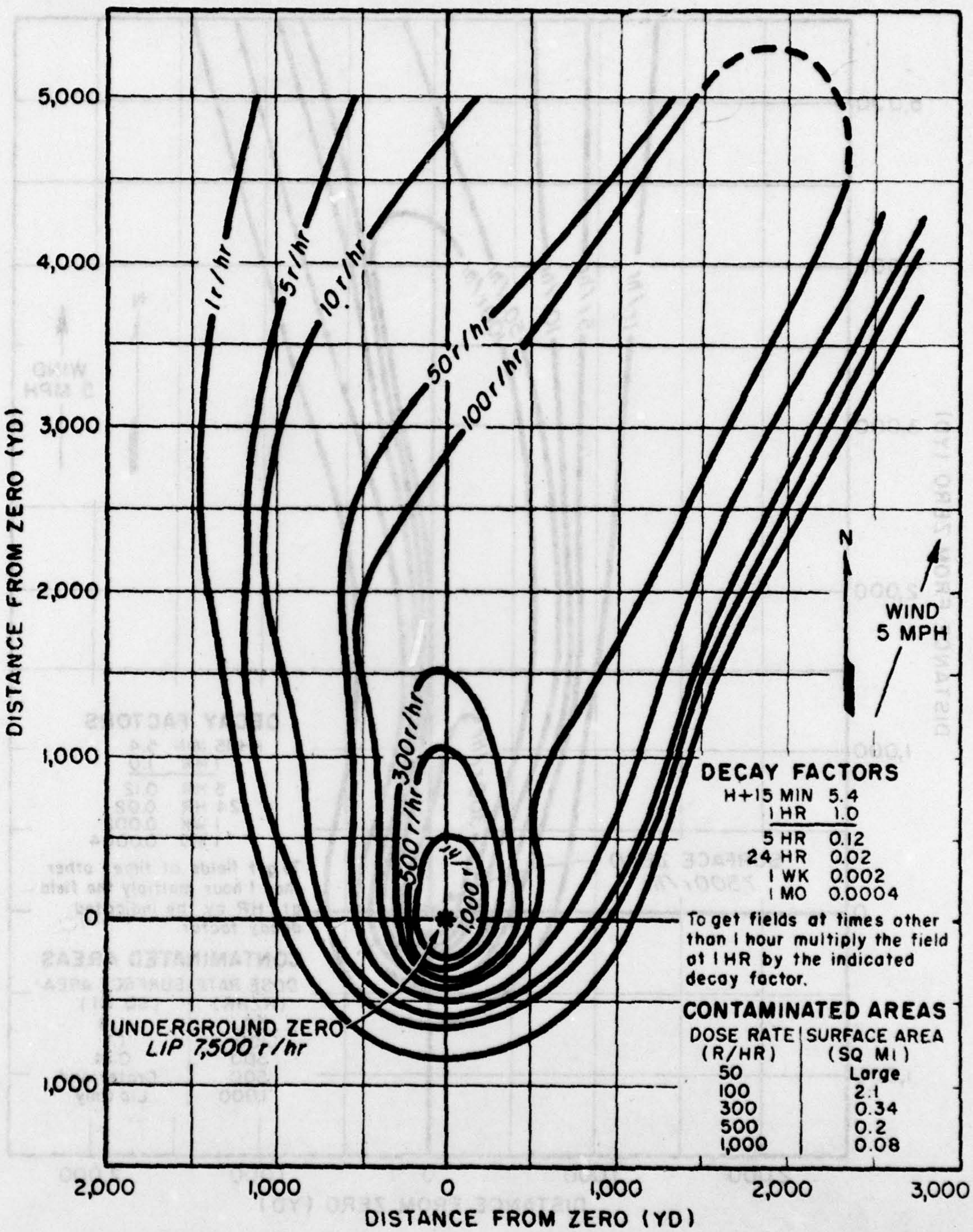

Fig. A.6 Gamma Dose-rate Contours at H + 1 hour, Underground Burst for Project 2.1d (Fig. 2, WT-370)

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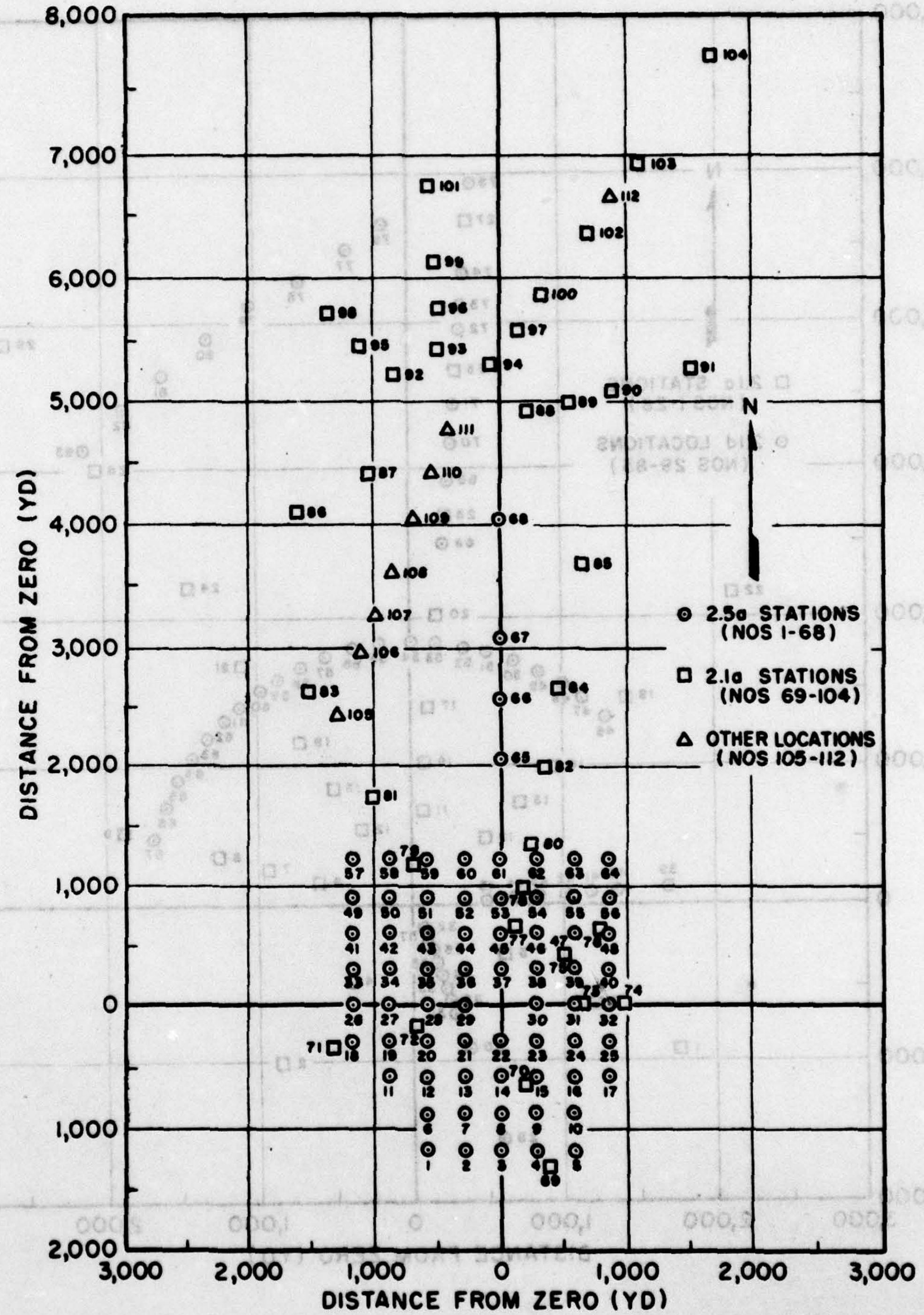

Fig. A.7 Station Layout, Surface Shot for Project 2.1d (Fig. 3, WT-370)

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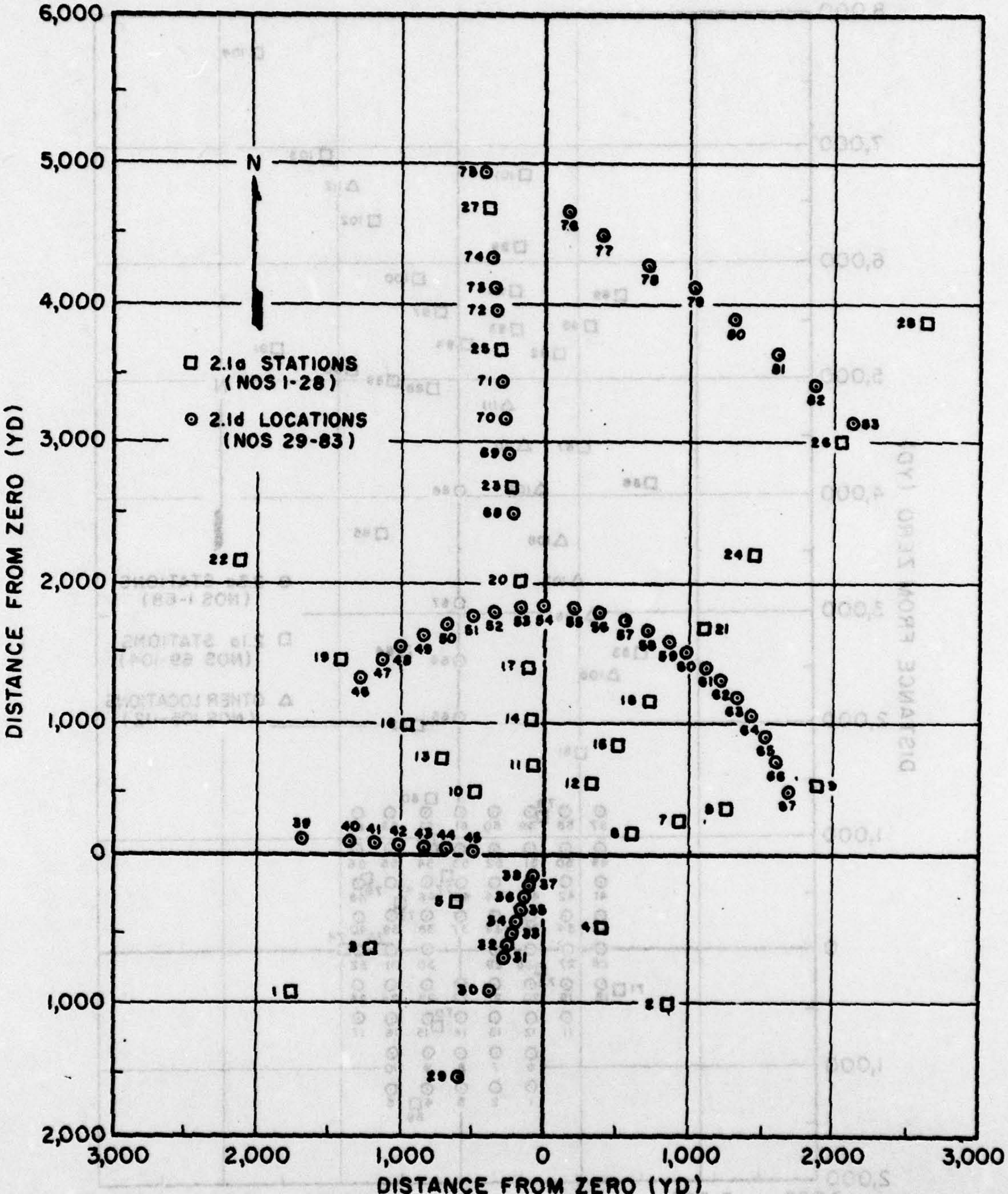

Fig. A.8 Station Layout, Underground Shot for Project 2.1d (Fig. 4, WT-370)

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Fig. A.9 Surface Explosion Field Gamma, as Roentgens per Hour one Hour after Burst, for Project 2.5a-2, (Fig. 4.19, WT-371). Intersections of Grid Lines Represent Station Locations.

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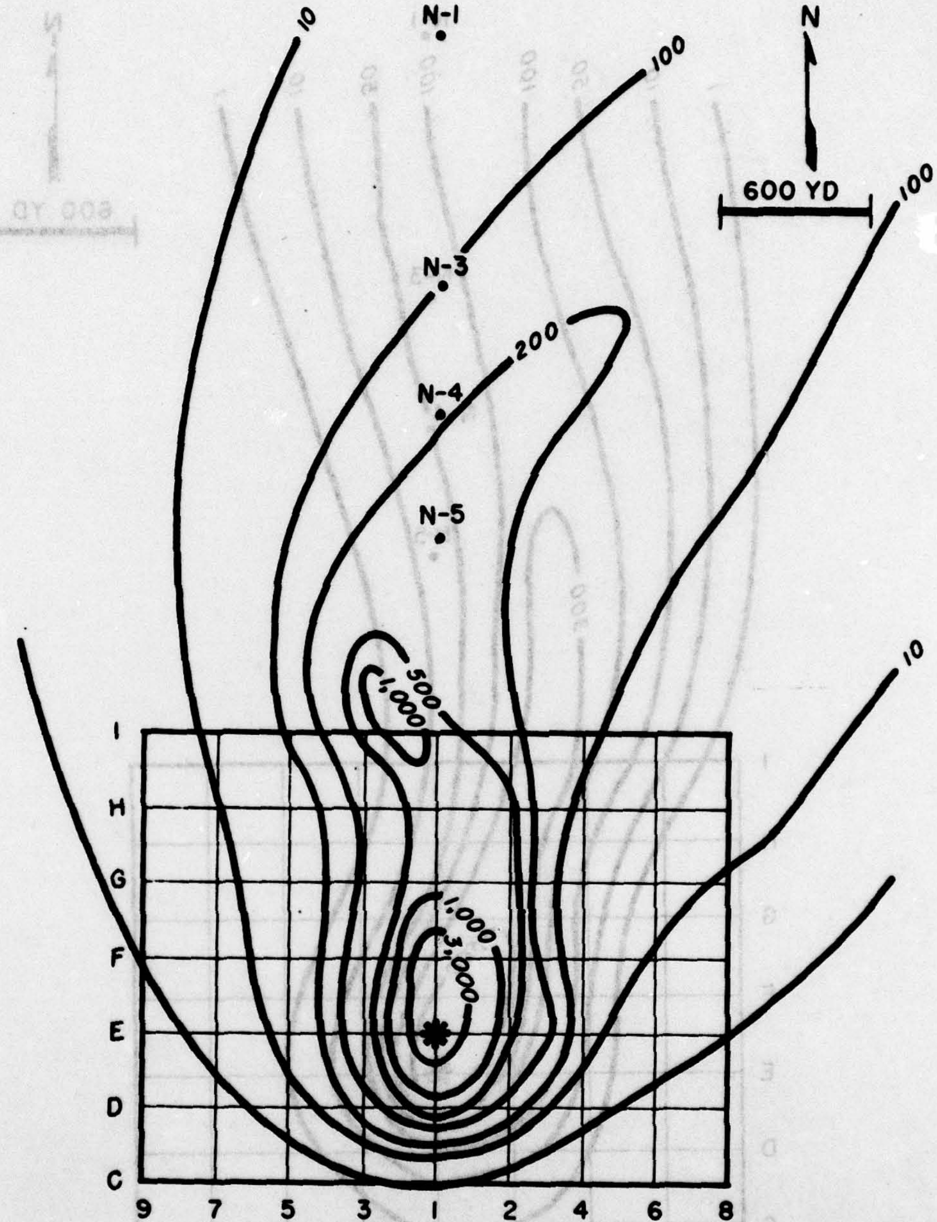

Fig. A.10 Underground Explosion Field Gamma, as Roentgens per Hour One Hour after Burst, for Project 2.5a-2 (Fig. 4.21, WT-371). Intersections of Grid Lines Represent Station Locations.

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12-14	Chief, Bureau of Supplies and Accounts (Code W)
15-16	Chief, Bureau of Yards and Docks (P-312)
17	Chief of Naval Research
18	Chief of Naval Operations (Op-36)
19	Commander, New York Naval Shipyard (Material Lab.)
20	Director, Naval Research Laboratory (Code 2021)
21	CO, Naval Unit, Army Chemical Center
22	CO, Naval Unit, CmlC Training Command
23	CO, U. S. Naval Civil Engineering (Res. and Eval. Lab.)
24	U. S. Naval School (CEC Officers)
25	CO, Naval Air Material Center, Philadelphia
26	Aviation Medical Acceleration Laboratory
27	CO, Naval Damage Control Training Center, Treasure Island
28	CO, Naval Damage Control Training Center, Philadelphia
29-31	Commander Training Command, U. S. Pacific Fleet
32	Commandant, Twelfth Naval District
33	Commander Air Force, Atlantic Fleet (Code 16F)
34	Commandant, U. S. Marine Corps
35-36	Commandant, Marine Corps Schools, Quantico
	ARMY
37	Chief of Engineers, Department of the Army (ENGEB, Dhein)
38-39	CG, CmlC Res. and Eng. Command, ACmlC, Maryland
40	CG, Chemical Corps Materiel Command
41-43	CO, CmlC Chemical and Radiological Laboratories (Library)
44	Radiological Division, CmlC Chemical and Radiological Lab.
45	Chemical Corps Training Command (Library)
46	Office of Chief Signal Officer (SIGGG-P)
47	President, Army Field Forces Board No. 1, Fort Bragg
48	Chief, Philadelphia Quartermaster Res. and Dev. Lab.
49	Quartermaster General, Department of the Army
50	CO, Engineer Res. and Dev. Lab.
51	CO, Dugway Proving Ground

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52	Operations Research Office
53	CO, Transportation Res. and Dev. Station, Fort Eustis
	AIR FORCE
54	CG, Air Materiel Command (MCMTM)
55	CG, Wright Air Development Center (WCOES)
56	CG, Wright Air Development Center (WCRTN)
57	CG, Wright Air Development Center (WCRTH-1)
58	CG, Air Res. and Dev. Command (RDDDN)
59	CG, Air Res. and Dev. Command (RDDDH)
60	CG, Strategic Air Command, Offutt Air Force Base (DM6A)
61	CG, Strategic Air Command (Operations Analysis Office)
62	CG, Special Weapons Command, Kirtland Air Force Base
63	Director, Air University Library, Maxwell Air Force Base
64-65	CG, Department of Armament Training, Lowry Air Force Base
66	CG, Cambridge Research Center (CRTSL-2)
67	CG, Cambridge Research Center (CRW)
	OTHER DOD ACTIVITIES
68	Chief, Armed Forces Special Weapons Project
69	AFSWP, Hq., Field Command, Sandia Base
70	AFSWP, Technical Training Group, Sandia Base
71	Res. and Dev. Board, Committee on Atomic Energy
	AEC ACTIVITIES AND OTHERS
72	AEC, Military Applications Division
73	AEC, Division of Research, Washington
74	AEC, Division of Biology and Medicine, Washington
75	Los Alamos Scientific Laboratory (J-Division)
76	Sandia Corporation (Document Room)
77-78	Sandia Corporation, Weapons Effect Department (1100)
79	Sandia Corporation (Lucero)
80	Los Alamos Scientific Laboratory (Redman)
	USNRDL
81-110	USNRDL, Technical Information Division

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